8.39 MARBLE HILL HOUSE - DAMP LEVEL INVESTIGATION

THE FLOYD CONSULTANCY

An investigation of dampness levels at

Marble Hill House, Twickenham

Survey: 05.12.12
Report: 30.01.13

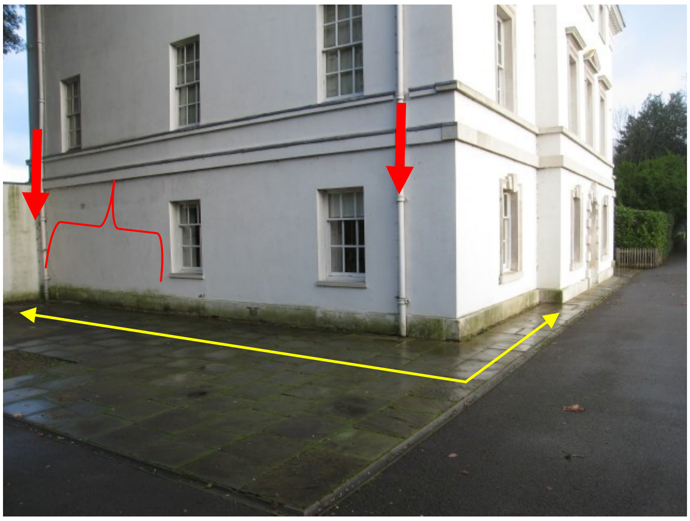
Tim Floyd MSc (Architectural materials science) MRICS (Research) – 0044(0)1562885806
14 Church Street, Hagley, Stourbridge, West Midlands DY9 0NA
www.thefloydconsultancy.co.uk

1 INTRODUCTION

Following instructions from Robert Illingworth of English Heritage, I visited the above building on Wednesday 5th December 2012 to investigate 2 areas of the ground floor – namely damage to the wall coverings in the Paper Room and damage to the floor in the Hall (see ground floor plan, page 10).

2 THE PAPER ROOM

Internal wall finishes are deteriorating in the NW corner of the building (Paper Room).

1 N elevation of Paper Room showing incorrect surface falls around the NW corner. Water is able to percolate between the pavoirs – presumably migrating to the wall base. Wall siphons (of some kind) have been installed to the extent of the red bracket. The plinth is composed of stone units. The facade finished in stucco.	
2 Wall siphons continue along W elevation to extent of bracket. Gulleys and possibly downpipes were blocked. (Drain runs recently inspected and found to be clear). External pavoirs do not seem to have sufficient falls away from building perimeter. Small trench installed at wall perimeter (yellow arrow) – filled with pea gravel – which was very wet. Plinth along W elevation has been covered (in render?).	

Tim Floyd MSc (Architectural materials science) MRICS (Research) – 0044(0)1562885806
14 Church Street, Hagley, Stourbridge, West Midlands DY9 0NA
www.thefloydconsultancy.co.uk

<table>
<tr>
<td>3

The N and W internal walls have been rendered with hard (almost certainly cementitious) render – much of which has blown (for one or a combination of reasons which will only become obvious after the damaged render is removed). In places salts are efflorescing through the surface.

The floor has been covered with a resin based substance – almost certainly as a damp proofing measure.

See masonry analysis.</td>
<td></td>
</tr>
</table>

2.1 Masonry analysis (column positions shown on ground floor plan)

Samples of the masonry were removed from the wall in accordance with BRE digest DG245. 3 columns were removed from the wall (A1 – 250mm, 2 – 500mm, 3 – 750mm, 4 -1000mm, 5 – 1500mm and 6 – 2000mm). Columns 1 and 3 are incomplete due to sampling difficulties at the columns bases (and top in the case of column 3).

The absolute moisture content (%mc) of a sample is derived from the difference between the wet and dry weights. The dried samples are then subjected to an environment suppressed at 75% relative humidity (RH). This particular RH is used as those minerals (or salts) which attract moisture at RHs<75% (*very loosely* referred to as hygroscopic salts) are generally considered to be more prevalent in ground as opposed to surface water. This is the hygroscopic moisture content of the sample (%hmc). Its presence and distribution profile within the wall *can* indicate a ground rather than surface water problem.

The positions of the columns are shown on the floor plan – (page 10). Very generally - %mcs are considered significant if >3% and %hmcs considered significant if >5%, although this would depend on whether a sample of stone, brick or mortar was being assessed.

Note:

As the removal of physical samples was possible in this instance, no environmental data was recorded. The building as a whole was previously fitted with a Meaco monitoring system together with an air conditioning system. All available data from the Meaco system has been obtained. However unfortunately the Paper Room was not monitored and no environmental data exists.

Sample	%mc	%hmc
Col 1 – Floor +250mm	No access	
+500mm	2.6	0.5
+750mm	3.3	0.0
+1000mm	2.4	0.0
+1500mm	4.4	1.0
+2000mm	4.4	0.4
Col 2 – Floor +250mm	1.1	0.4
+500mm	1.2	0.4
+750mm	10.2	0.0
+1000mm	7.4	0.6
+1500mm	0.0	0.8
+2000mm	1.5	0.5
Col 3 – Floor +250mm	No access	
+500mm	1.8	0.7
+750mm	8.0	2.1
+1000mm	1.6	0.5
+1500mm	1.9	0.6
+2000mm	No access	

2.2 Discussion

The masonry samples show the N wall is evenly damp – almost to ceiling height (2000mm).

The W wall shows a (very) wet band at 750 – 1000mm above floor level. This would seem to be a result of the wall construction – where the masonry below about 500mm (see photo 2) is an enlarged (stone) plinth – with that above probably being soft brick encased in hard render. The plinth along the W elevation has been covered in a render. It is probable that wind driven rain is running down the wall to the step created by the plinth – then capillarising into and behind the base of the external render. The covering of the plinth might also be allowing water to track up between the covering and the plinth itself from the wet trench.

A *similar* process is probably on going along the N elevation, with the difference being the plinth is exposed stone and there is no high volume water collection system such as the stone filled trench along the W and S elevations. The perpetual shade experienced by the N elevation will also effect how water moves in the wall. However on balance of probabilities the moisture distribution in the N wall (being evenly damp to 2000mm) would seem to be related to preferential moisture transference from the abutting W wing wall to the sheltered N facade. The construction of the W wing wall is different to the house generally. As such it is possible water is able to move more freely in it and transfer into the N wall of the main building.

What is clear is that there have been ongoing battles with the high moisture levels in these two walls for many years. While the installation of wall siphons might be exacerbating the problem, introduction of the gravel filled trench along the W elevation with blocked gulleys and downpipes overflowing into them - almost certainly has.

It is probable that the renovations and alterations carried out by the GLC in the mid 60s would have included alterations to the external ground, possibly including the addition of tarmaced surfaces up to the pavoirs on the N, W and S elevations. The addition of the tarmaced surfaces (carried out by whoever and whenever), would probably have set in motion a chain of events culminating in the problems experienced today.

2.3 Recommendations

Ideally the incorrect falls of the surrounding hard standings to the N, W and S elevations must be addressed. This would involve relaying all the pavoirs around the N, W and S elevations to fall away from the building perimeter and installing either sub surface or open channel drains to collect and discharge all collected surface water. However achieving a solution to this (and the problematic junction of the W wing wall with the NW corner of the building) would be so invasive as to make it impractical.

The stone filled trench along the W and S elevations could be replaced with an open channel which discharges into the downpipe gullies. The ends of the downpipes should be changed to spouts which discharge into the same grated gulleys as opposed to travelling sub surface where they become blocked out of view. This should decrease the water loading on the W wall.

A small amount of groundwork to the N elevation should bring long term benefits, where the pavoirs shown in photo 1 could be relayed (and well grouted) to fall away from the building. However water collection/discharge could be a problem due to the existing falls. The only possibility would seem to be the installation of a soakaway in the front lawn.

Even if a large scale groundwork project addressing all the points above was initiated, the N and W walls would remain wet for many months and years and certain measures would have to be carried out internally regardless of any external works.

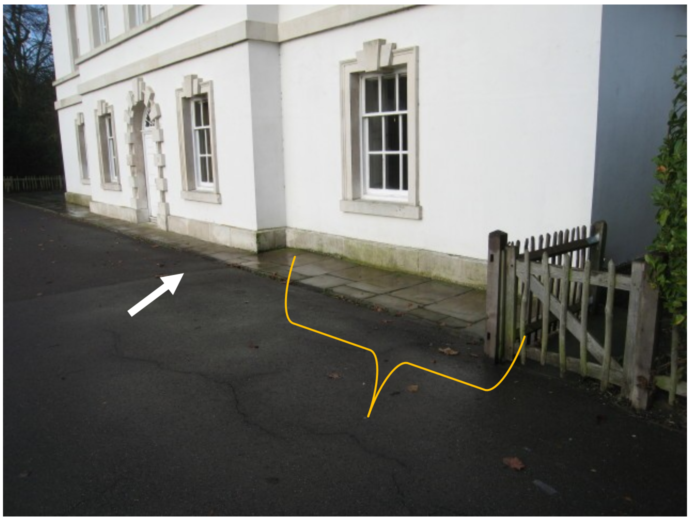
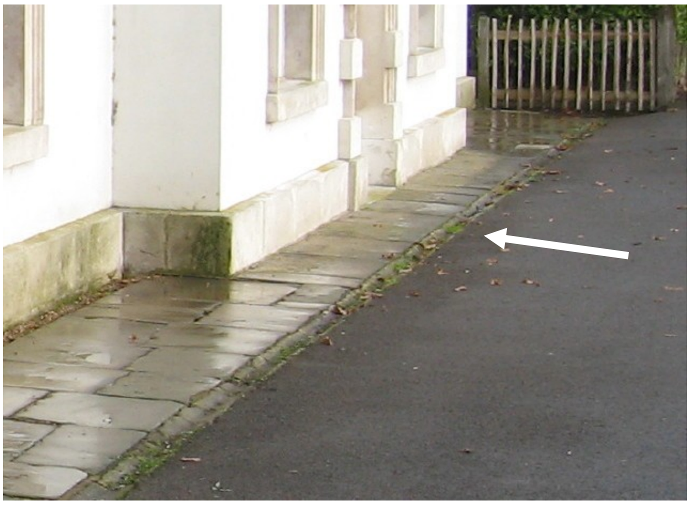
Internally all loose plaster should be removed from the N and W walls. This will have to be carried out with care (to preclude the damage which often results when chiselling well bonded cementitious material off soft brickwork). Ordinarily the recommendation would be to line the wall in moisture resistant plasterboard and simply allow the wall to be damp. This might have been rejected in the past due to the difficult curves and contours in the W wall and it will probably now be necessary to board straight over the alcove. Any well bonded cementitious render can just remain on the wall. The wall lining will have to be well designed around the N window and ideally the cavity should be air tight.

However the overall design of the wall lining and cavity can only be finalised when the loose render has been removed and the extent of the wall siphons and condition of the masonry have been confirmed. It would be advisable to block the siphon cavities completely.

3 THE HALL

Deterioration of the stone floor tiles in the SE corner of the Hall has recently accelerated (photo 6).

The upper 1 – 4mm of the floor tiles (probably limestone) has delaminated locally, leaving spots of lighter coloured substrate.

4 Problems with collection and discharge of surface water – similar to that shown in photo 1. Water has been percolating into the cellar (extent shown by bracket), causing plaster loss from the S wall	
5 The open channel – into which the tarmac and pavoirs shed water – has open joints and falls to the point arrowed - where leaves have been collected then deposited where the water has disappeared. below ground	

6 The floor surface is darkening – possibly due to excess moisture, with small areas of the floor surface disassociating from the floor tiles. It is understood this process has accelerated recently.	

3.1 Data collection and analysis

In situations where physical sampling is not possible, collection of environmental data is often the next best thing.

The environment of the Hall was monitored for a month. A logger was sealed against the floor surface over the damage. A second logger was adjacent to the first but unsealed and able to equilibrate with the air in the Hall – circled in photo 6. The window shutters were closed for the monitoring period. These data sets are shown in graph 1 at the end of the report.

The environment of the cellar was also monitored for the same period as this is possibly the main point of moisture ingress and almost certainly affects the environment of the Breakfast Parlour (and therefore the Hall) – graph 2.

The building is equipped with a Meaco monitoring system. All available data was acquired. Although the Hall and the adjacent Dining Room are monitored – no data from these areas was made available. Data sets from the Breakfast Parlour were obtained – and are shown in graphs 3 – 5.

At the time of writing this report, details of the air conditioning system used in the building have yet to be made available.

3.2 Discussion

Graph 1

The data from graph 1 shows the environment at the floor surface to be approaching 90%RH indicating there is excess moisture at the floor surface. The environment of the Hall generally has a much more variable RH. Looking at 01/01/2012 for example, in a 24 hour period the RH ranges from over 70% (equating with an air moisture loading of 9g H_2O/M^3) down to under 55% (7g H_2O/M^3). This variation occurs at a relatively stable 15^{0}C temperature showing that moisture is probably being extracted from the environment – but being reintroduced - 24 hours later. The reason for this is unclear.

Graph 2

As would be expected the environment of the cellar is stable. There was no great difference in the environments of the air at ceiling and floor – with the levels gradually rising to a constant 70%RH @ 20^{0}C. This equates to reasonably high level of air moisture which either finds its way up into the Breakfast Parlour, condenses out on walls elsewhere in cooler parts of the basement or exits the basement completely through vents in the cellar door.

Graphs 3 – 5

The environment of the Breakfast Parlour is as variable as that of the Hall. Graph 4 shows the data from June only. Although the sun is at its highest, this data set should represent that period when the S facade is affected most by solar gain.

It can be seen that although the temperature is maintained between 17 - 20^{0}C, the RH ranges from 52% - 75%. Again this is likely to be the result of air conditioning, with moisture emanating from the cellar below.

General

Graph 1 confirms there is excess moisture at the floor surface which is likely to have emanated from the external defective surface drainage - *if the pre existing moisture in the room is regularly removed by the air conditioning system*. Graphs 2 – 5 seem to show that water is also drawn from the defective external perimeter surfaces into the (elevated and constant air temperatures of the) cellar. Graphs 3 – 5 indicate the temperature of the Breakfast Parlour is probably affected more by the cellar below - as its temperature is closer to that of the cellar rather than the Hall. Graph 5 should be treated with a degree of caution due to breaks in the data and high readings recorded in June 2012.

The existence of the air conditioning system probably makes the movement of water from outside to in (and therefore the deterioration of the floor surface which is probably caused by salt migration and crystallisation) - more efficient. However this can only be confirmed when more information on the system is obtained – see recommendations.

3.3 Recommendations

The open channel arrowed in photo 5 could be repaired to collect and discharge surface water more effectively. While the overall problems with surface water collection and defective falls are similar to those experienced on the W and N walls, repair of the open channel arrowed in photo 5 should produce particularly good results along this elevation in the long term.

If, in an ideal world, all water ingress could be stopped, the drying rate of the wall base and consequently the sub floor of the Hall would be dependent on the internal air conditioning.

It is widely accepted that the %RH of air within a museum or building containing organic delicates should be maintained between 45 – 60% - with the gold standard 55%. Assuming the environment is effectively sealed (windows and doors do not remain open), maintaining a stable temperature is often all that is required to maintain a stable RH. However, in this case a stable temperature has not maintained the RH which is a matter for concern not so much for the condition of the Hall floor, but for the rest of the collection housed in the building.

As such it is important that following repair of the open channel along the S elevation, the existing systems of the building are fully assessed, namely:

- Air conditioning

It is important that a full map of the air conditioning system is obtained. This should include:

When it was installed.

What type of system has been employed (simple air circulation or more advanced HVAC system).

How and where it has been fitted within the building (it is known to use existing flues and fireplaces to an extent).

How it is activated – humidistat, thermostat, timer etc – and what the program settings are.

How and when it was last calibrated/serviced.

- Environmental monitoring

The Meaco system requires upgrading. This could be possible with a change of software and possibly an upgrade of the controller (the unit responsible for interrogating the sensors and storing the data). The sensors require recalibration but can probably be retained.

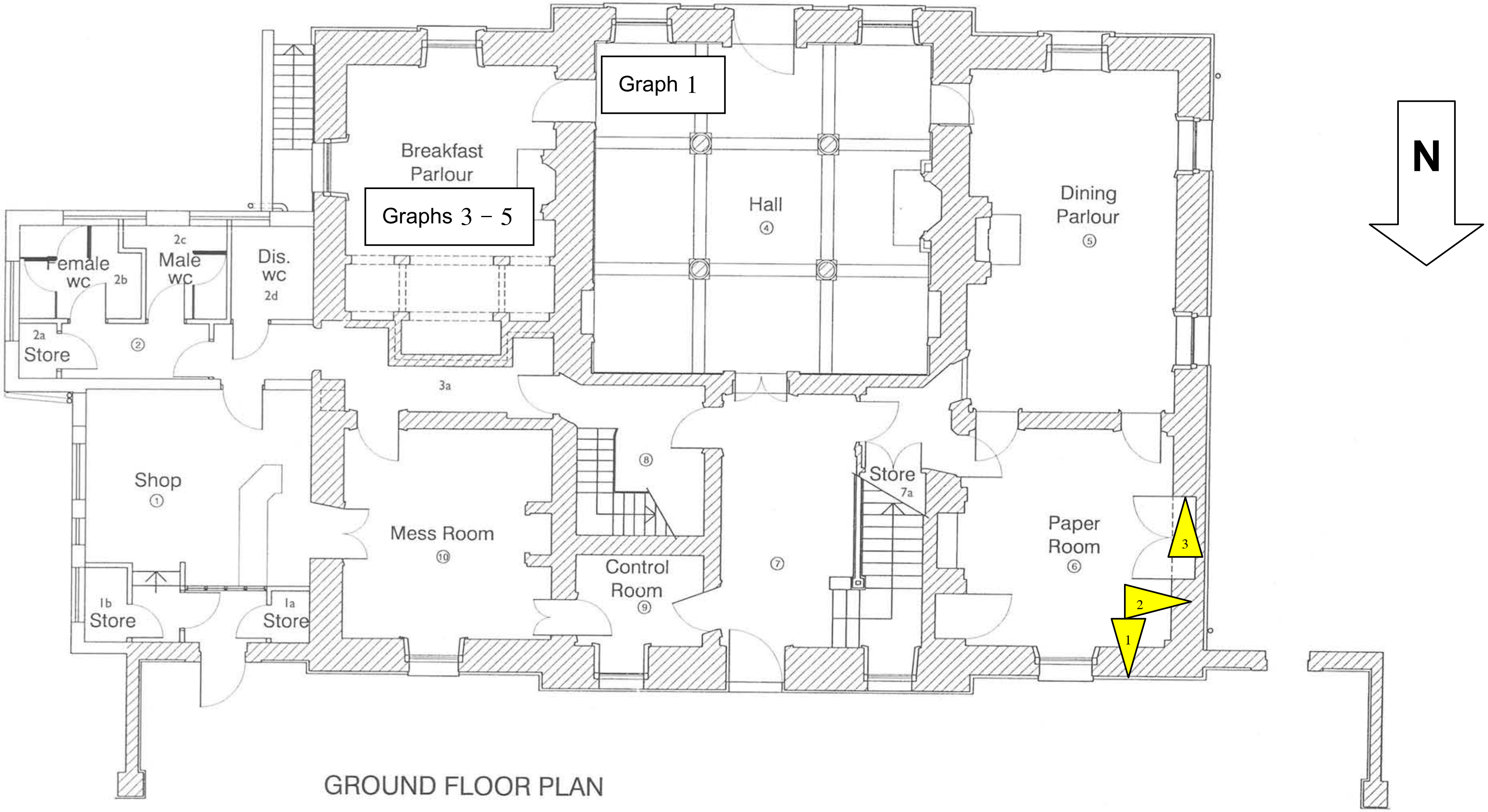
A system should then be put in place where the data is downloaded (by the property manager?) to a separate file and analysed/checked every year at the very least.

Maintaining a %RH at 50 – 60% is good for collections, although excess/residual moisture from the sub floor will still be able to migrate through the floor tiles – causing continued deterioration for a time.

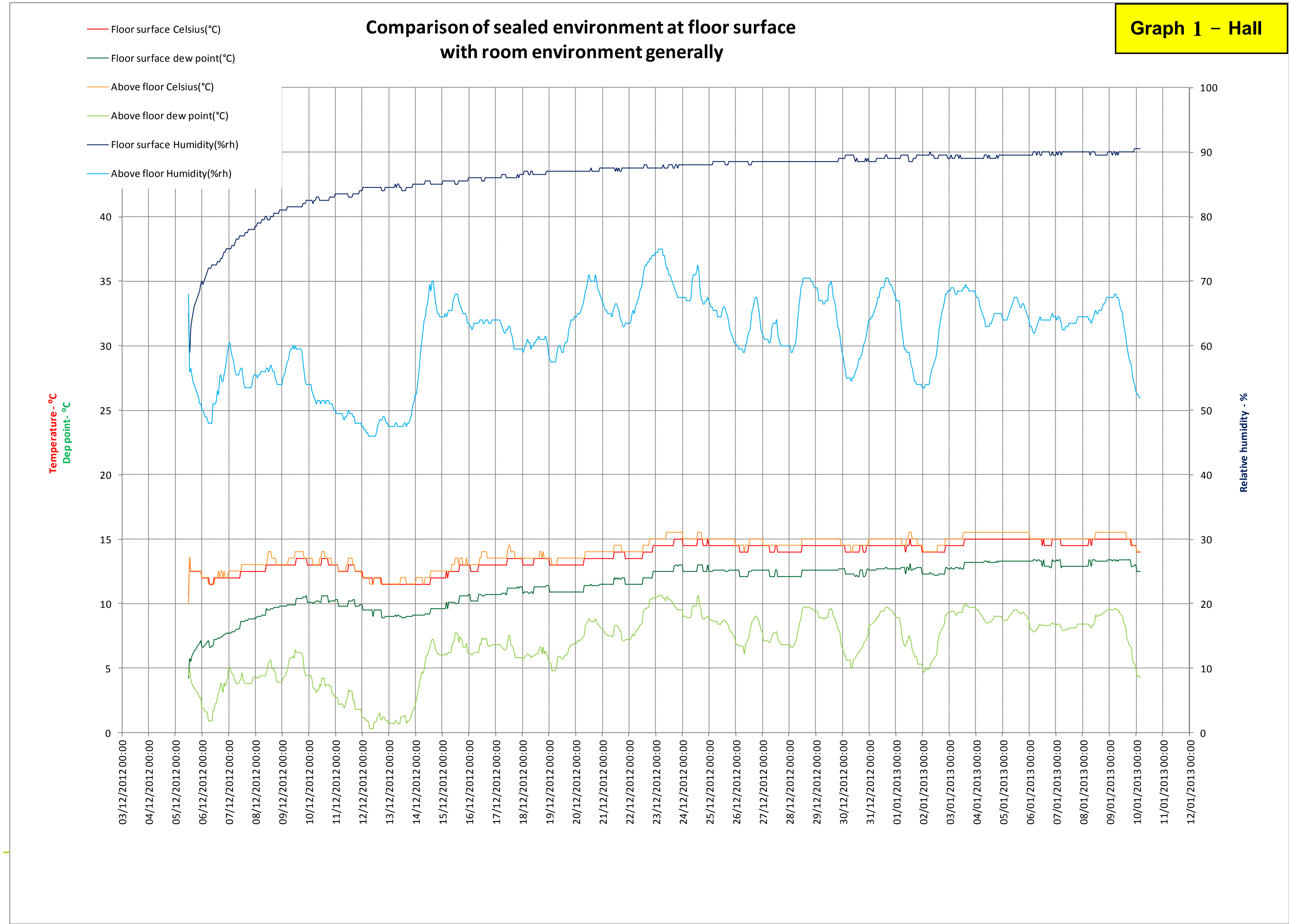
However if the environmental monitoring system is over hauled – with sensors placed at floor level in the hall – the efficacy of addressing external surface water should be measurable over months and years.

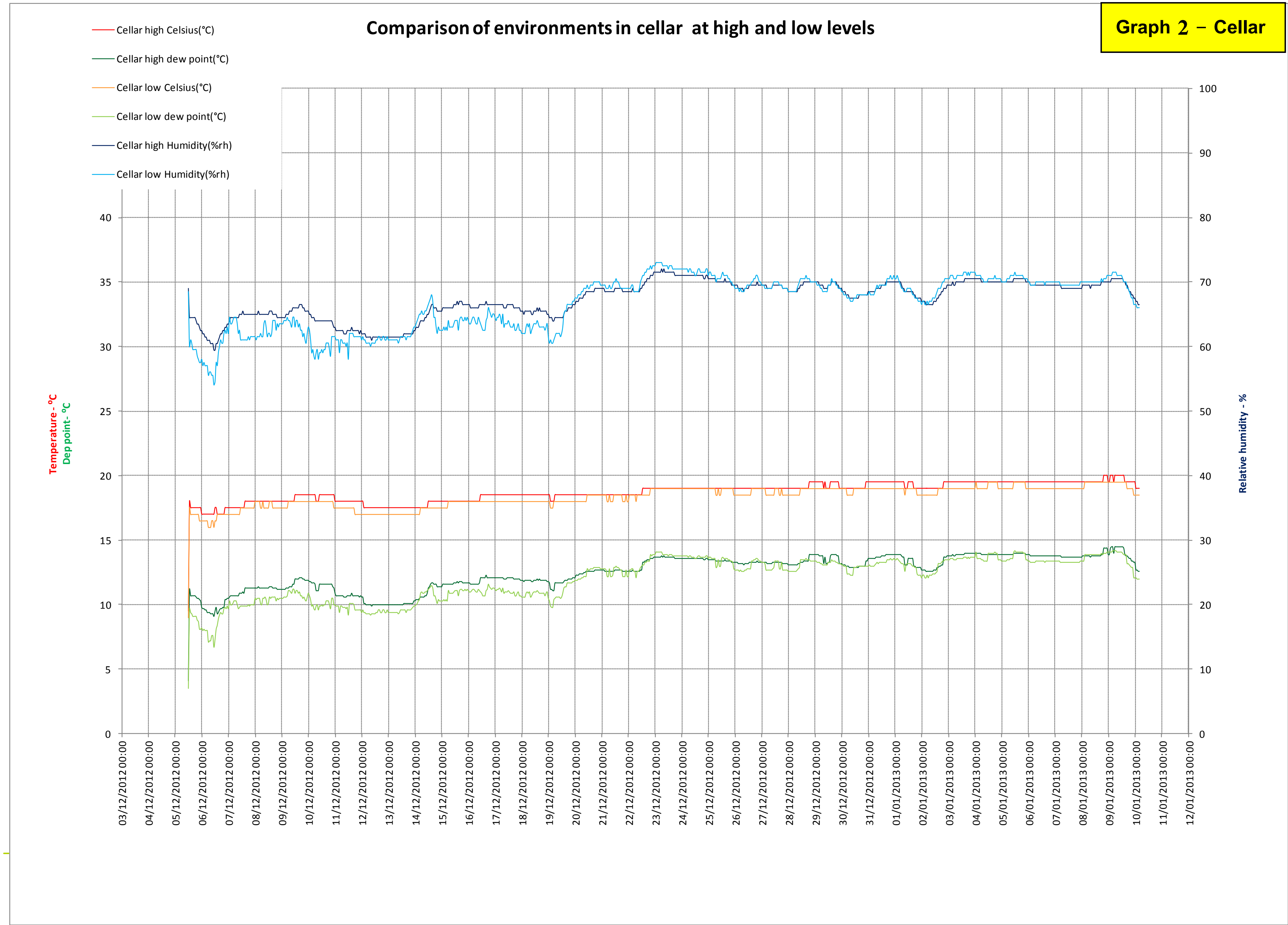
When more information on the air conditioning has been received – further recommendations will follow.

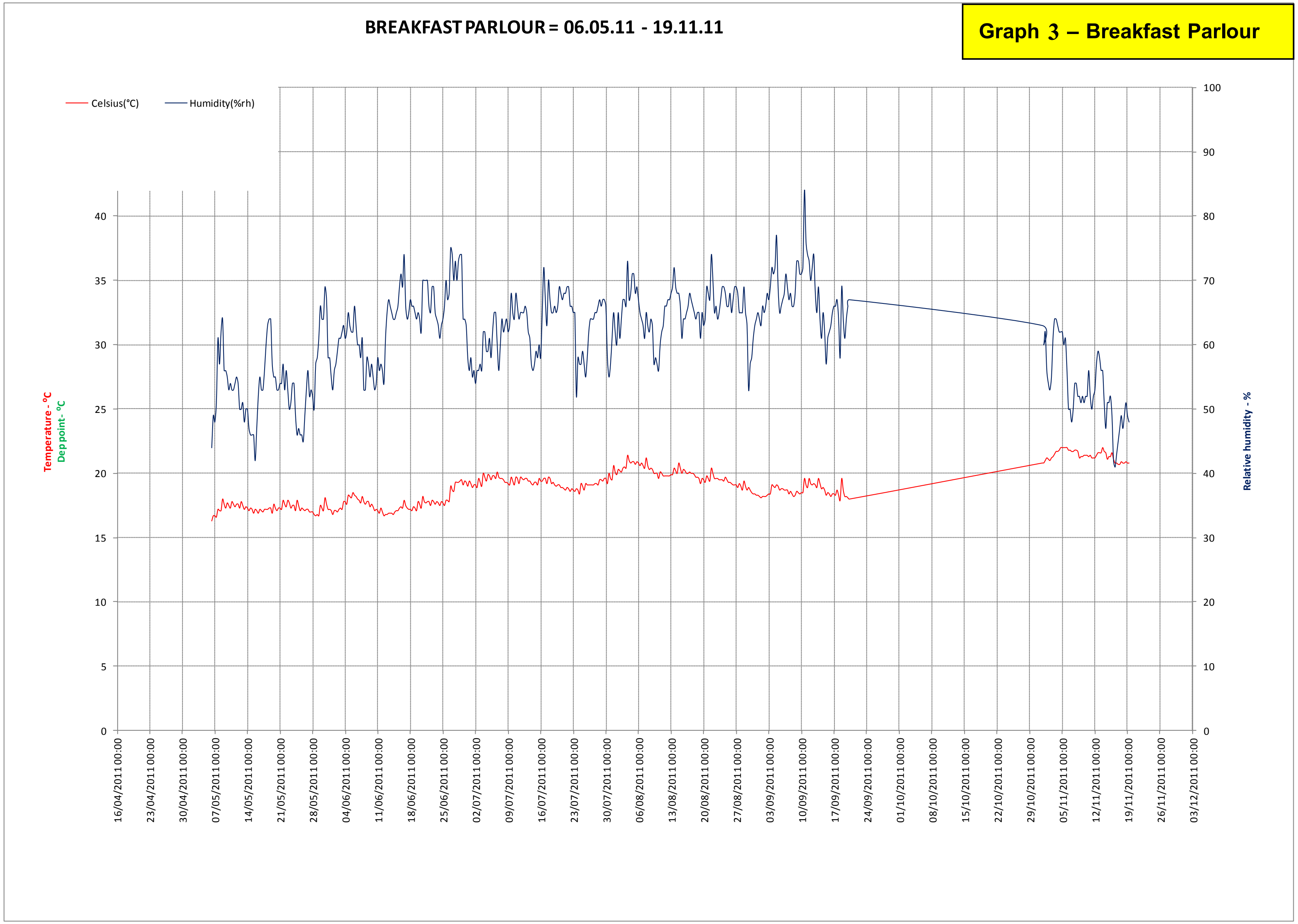
Tim Floyd – January 2013



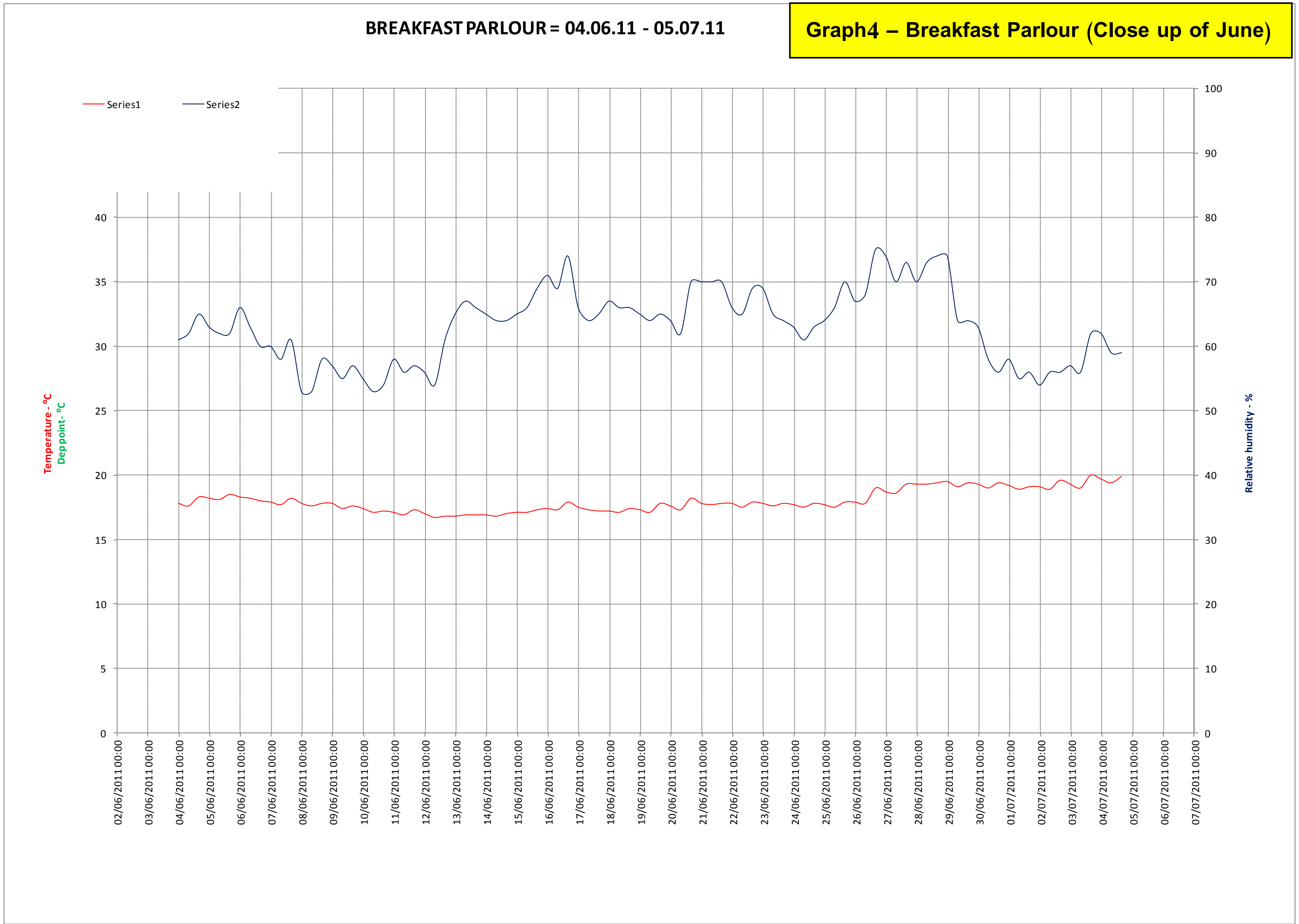
Tim Floyd MSc (Architectural materials science) MRICS (Research) – 0044(0)1562885806
14 Church Street, Hagley, Stourbridge, West Midlands DY9 0NA
www.thefloydconsultancy.co.uk

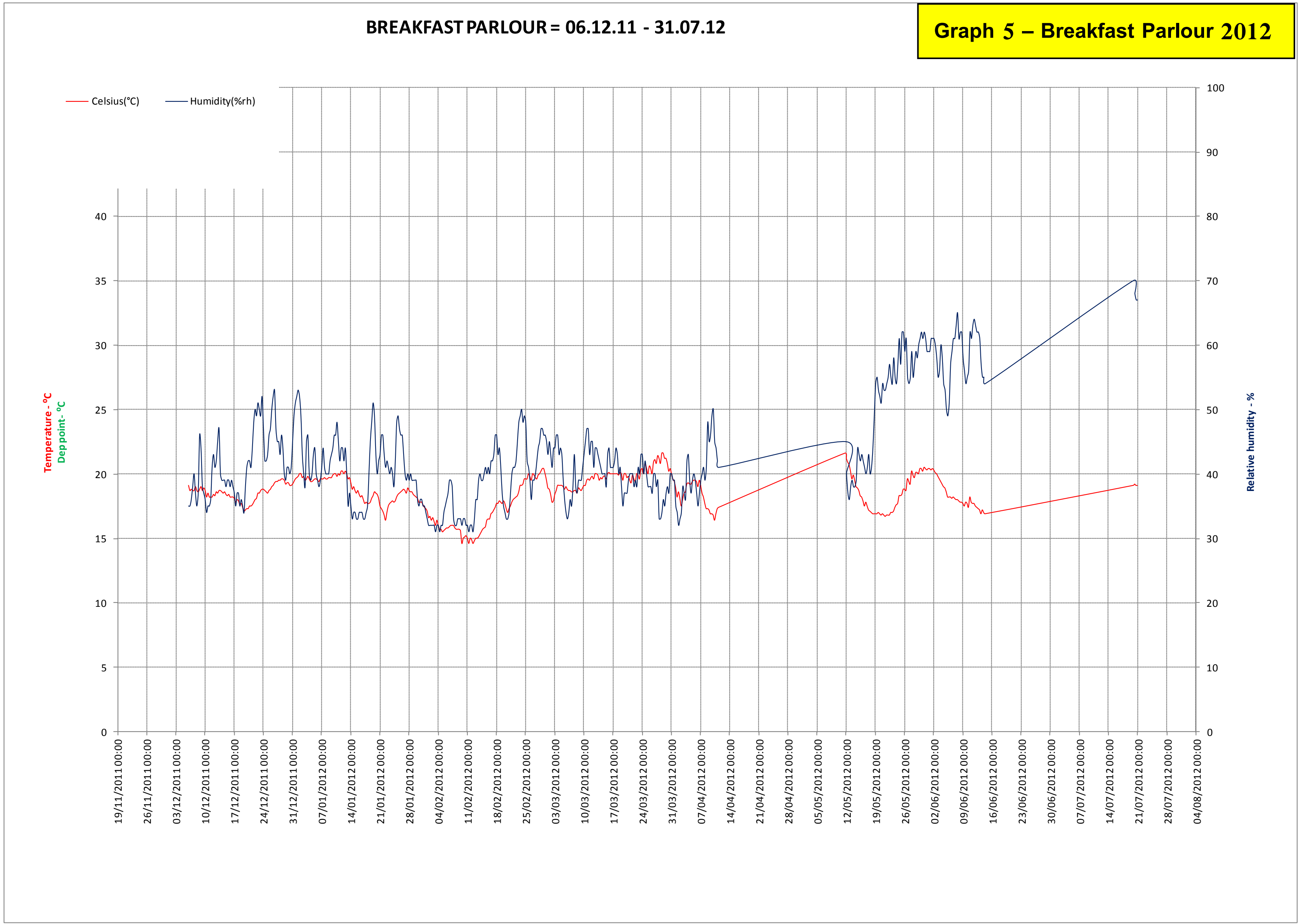

Comparison of sealed environment at floor surface with room environment generally
Graph 1 – Hall
Floor surface Celsius(°C)
Floor surface dew point(°C)
Above floor Celsius(°C)
Above floor dew point(°C)
Floor surface Humidity(%rh)
Above floor Humidity(%rh)
Temperature - °C
Dep point - °C
Relative humidity - %
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70
80
90
100
03/12/2012 00:00
04/12/2012 00:00
05/12/2012 00:00
06/12/2012 00:00
07/12/2012 00:00
08/12/2012 00:00
09/12/2012 00:00
10/12/2012 00:00
11/12/2012 00:00
12/12/2012 00:00
13/12/2012 00:00
14/12/2012 00:00
15/12/2012 00:00
16/12/2012 00:00
17/12/2012 00:00
18/12/2012 00:00
19/12/2012 00:00
20/12/2012 00:00
21/12/2012 00:00
22/12/2012 00:00
23/12/2012 00:00
24/12/2012 00:00
25/12/2012 00:00
26/12/2012 00:00
27/12/2012 00:00
28/12/2012 00:00
29/12/2012 00:00
30/12/2012 00:00
31/12/2012 00:00
01/01/2013 00:00
02/01/2013 00:00
03/01/2013 00:00
04/01/2013 00:00
05/01/2013 00:00
06/01/2013 00:00
07/01/2013 00:00
08/01/2013 00:00
09/01/2013 00:00
10/01/2013 00:00
11/01/2013 00:00
12/01/2013 00:00


Comparison of environments in cellar at high and low levels
Graph 2 – Cellar
Cellar high Celsius(°C)
Cellar high dew point(°C)
Cellar low Celsius(°C)
Cellar low dew point(°C)
Cellar high Humidity(%rh)
Cellar low Humidity(%rh)
Temperature - °C
Dep point - °C
Relative humidity - %
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70
80
90
100
03/12/2012 00:00
04/12/2012 00:00
05/12/2012 00:00
06/12/2012 00:00
07/12/2012 00:00
08/12/2012 00:00
09/12/2012 00:00
10/12/2012 00:00
11/12/2012 00:00
12/12/2012 00:00
13/12/2012 00:00
14/12/2012 00:00
15/12/2012 00:00
16/12/2012 00:00
17/12/2012 00:00
18/12/2012 00:00
19/12/2012 00:00
20/12/2012 00:00
21/12/2012 00:00
22/12/2012 00:00
23/12/2012 00:00
24/12/2012 00:00
25/12/2012 00:00
26/12/2012 00:00
27/12/2012 00:00
28/12/2012 00:00
29/12/2012 00:00
30/12/2012 00:00
31/12/2012 00:00
01/01/2013 00:00
02/01/2013 00:00
03/01/2013 00:00
04/01/2013 00:00
05/01/2013 00:00
06/01/2013 00:00
07/01/2013 00:00
08/01/2013 00:00
09/01/2013 00:00
10/01/2013 00:00
11/01/2013 00:00
12/01/2013 00:00



BREAKFAST PARLOUR = 06.05.11 - 19.11.11
Graph 3 – Breakfast Parlour
Celsius(°C)
Humidity(%rh)
Temperature - °C
Dep point - °C
Relative humidity - %
0
5
10
15
20
25
30
35
40
100
90
80
70
60
50
40
30
20
10
0
16/04/2011 00:00
23/04/2011 00:00
30/04/2011 00:00
07/05/2011 00:00
14/05/2011 00:00
21/05/2011 00:00
28/05/2011 00:00
04/06/2011 00:00
11/06/2011 00:00
18/06/2011 00:00
25/06/2011 00:00
02/07/2011 00:00
09/07/2011 00:00
16/07/2011 00:00
23/07/2011 00:00
30/07/2011 00:00
06/08/2011 00:00
13/08/2011 00:00
20/08/2011 00:00
27/08/2011 00:00
03/09/2011 00:00
10/09/2011 00:00
17/09/2011 00:00
24/09/2011 00:00
01/10/2011 00:00
08/10/2011 00:00
15/10/2011 00:00
22/10/2011 00:00
29/10/2011 00:00
05/11/2011 00:00
12/11/2011 00:00
19/11/2011 00:00
26/11/2011 00:00
03/12/2011 00:00


BREAKFAST PARLOUR = 04.06.11 - 05.07.11
Graph4 – Breakfast Parlour (Close up of June)
Series1
Series2
Temperature - °C
Dep point- °C
Relative humidity - %
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70
80
90
100
02/06/2011 00:00
03/06/2011 00:00
04/06/2011 00:00
05/06/2011 00:00
06/06/2011 00:00
07/06/2011 00:00
08/06/2011 00:00
09/06/2011 00:00
10/06/2011 00:00
11/06/2011 00:00
12/06/2011 00:00
13/06/2011 00:00
14/06/2011 00:00
15/06/2011 00:00
16/06/2011 00:00
17/06/2011 00:00
18/06/2011 00:00
19/06/2011 00:00
20/06/2011 00:00
21/06/2011 00:00
22/06/2011 00:00
23/06/2011 00:00
24/06/2011 00:00
25/06/2011 00:00
26/06/2011 00:00
27/06/2011 00:00
28/06/2011 00:00
29/06/2011 00:00
30/06/2011 00:00
01/07/2011 00:00
02/07/2011 00:00
03/07/2011 00:00
04/07/2011 00:00
05/07/2011 00:00
06/07/2011 00:00
07/07/2011 00:00


BREAKFAST PARLOUR = 06.12.11 - 31.07.12
Graph 5 – Breakfast Parlour 2012
Celsius(°C)
Humidity(%rh)
Temperature - °C
Dep point- °C
Relative humidity - %
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70
80
90
100
19/11/2011 00:00
26/11/2011 00:00
03/12/2011 00:00
10/12/2011 00:00
17/12/2011 00:00
24/12/2011 00:00
31/12/2011 00:00
07/01/2012 00:00
14/01/2012 00:00
21/01/2012 00:00
28/01/2012 00:00
04/02/2012 00:00
11/02/2012 00:00
18/02/2012 00:00
25/02/2012 00:00
03/03/2012 00:00
10/03/2012 00:00
17/03/2012 00:00
24/03/2012 00:00
31/03/2012 00:00
07/04/2012 00:00
14/04/2012 00:00
21/04/2012 00:00
28/04/2012 00:00
05/05/2012 00:00
12/05/2012 00:00
19/05/2012 00:00
26/05/2012 00:00
02/06/2012 00:00
09/06/2012 00:00
16/06/2012 00:00
23/06/2012 00:00
30/06/2012 00:00
07/07/2012 00:00
14/07/2012 00:00
21/07/2012 00:00
28/07/2012 00:00
04/08/2012 00:00